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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04N 7/18, 7/15 — A1

(11) International Publication Number: WO 00/60867

(43) International Publication Date: 12 October 2000 (12.10.00)

(21) International Application Number: PCT/CA00/00339

(22) International Filing Date: 31 March 2000 (31.03.00)

(30) Priority Data:

09/286,433	6 April 1999 (06.04.99)	US
2,268,238	6 April 1999 (06.04.99)	CA

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(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

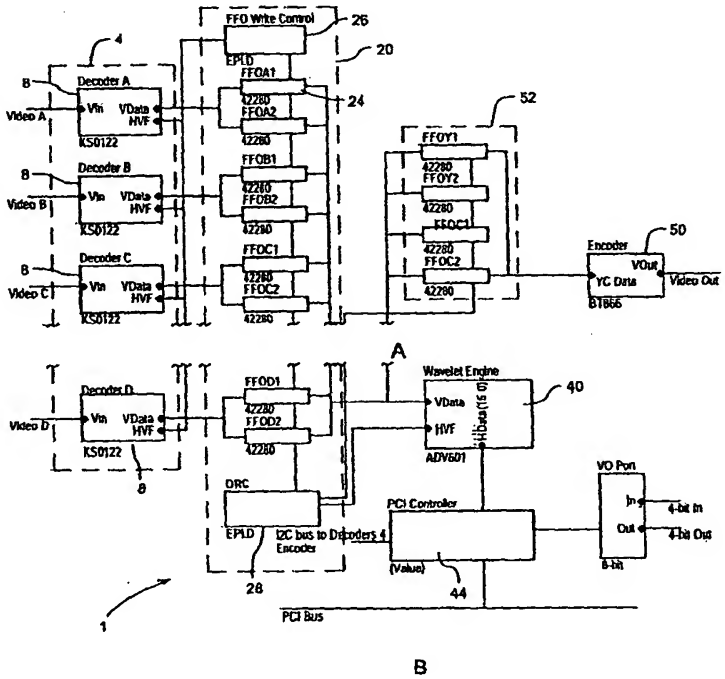
With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: DIGITAL VIDEO LAN SYSTEM

(57) Abstract

This invention discloses a digital video system for use in a LAN. The system comprises a video digitizer for receiving and digitizing a plurality of analog video inputs. A mixer receives the plurality of digitized video signals for spatially mixing the signals in real time into a single frame of a predetermined n by m pixel images. The digitized images are coupled to a video compressor for compressing each of the single frame images transmitting the images on a LAN to a receiver. The receiver decompresses the transmitted images for near real time display. In a preferred embodiment, the compression used is wavelet compression.



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DIGITAL VIDEO LAN SYSTEM

The present invention relates to a video monitoring and display systems for use in a LAN environment, and more particularly to a digital video mixer and compressor system.

BACKGROUND OF THE INVENTION

It is well known to provide video security systems in which video cameras are used to generate video signals representative of locations for which security surveillance is desired. In a typical system, some or all of the video signals are displayed on separate video screens for monitoring by security personnel. It is also known to record some or all of the video signals on video tape, either to provide evidentiary support for the observations by security personnel or in cases where "real-time" human monitoring of the signals is impractical or is not desired.

However, video tape suffers from serious drawbacks as a storage medium, particularly in view of the large quantity of video information generated by video security systems. A major concern is the sheer quantity of tapes to be stored, especially when it is desired to record signals generated by a large number of surveillance cameras. Moreover, in a large system many video tape recorders may be required, resulting in a large capital expenditure, and also the need for allocate space for the recorders. Another problem is the need to frequently change tape cassettes.

In United States Patent 4,943,854 a Video surveillance system for selectively selecting processing and displaying the outputs of a plurality of TV cameras is described. The multi-video recorder incorporates a multiplexing means permitting selection of the video signal from each of a plurality of TV cameras according to a predetermined importance or priority, and a priority changed due to occurrence of a new event and transmission of the video image thus selected over a single line and recording it by a single video tape recorder by time shared multiplexing the video signal at every frame, field or unit of time. It also can reproduce or demultiplex the video signal recorded as multiplexed, with each designated TV camera or by sequentially selecting the video signal from each TV camera. The system also has a means for inserting in the time shared multiplexed video signal and control signal such as select information, event information, time information or the like, so it can selectively demultiplex the video signals recorded as multiplexed, as desired.

In order to display full motion video, a frame rate of 30 frames per second (fps) is normally required. A limitation of the time-shared multiplexed systems is the reduced frame rate and hence choppy picture. For example, for four video inputs, a multiplexed system will have a reduced frame rate of approximately 7.5 frames per second. Furthermore, in current systems if groups of cameras are located a relatively remote area, the video signal has to be fed back to a central recording or monitoring station. This requires multiple coaxial cables for video transmission, or even if a multiplexing technique is used, a single long length of coaxial cable is required. Long cable runs require line amplifiers. In both cases, the costs are substantial.

A further disadvantage of current systems is that the images are recorded as analog signals on VHS or similar tapes, making archiving cumbersome.

Thus there is a need for a system that reduces the reliance on coaxial cable for video transmission, allows a distributed system architecture instead of linking all cameras individually, hence saving in cabling and line amplifier costs. Furthermore such a system should provide digital video or image recording on a computer mass storage device or the like , including being able to run under software control for providing flexibility of controlling image routing or viewing, recording, playback and archiving.

Current systems do not provide live speed and quality across multiple channels nor do they provide flexibility of a large number of cameras without losing frames.

SUMMARY OF THE INVENTION

The present invention seeks to provide a solution to the problem of combining multiple video inputs into a single display without a significant loss of frames.

In accordance with this invention there is provided a digital video system comprising:

a) a video mixer for spatially mixing a plurality of analog video input signals in real time and compressing said mixed signals for transmission; and

b) a receiver for receiving and decompressing said compressed signals for display in near real time.

In accordance with a further embodiment of the invention there is provided a plurality of video mixers coupled to a network and a transmitter for receiving the compressed images from the plurality of transmitters.

In accordance with a still further embodiment there is provided a video system comprising:

a) a video digitizer for receiving and digitizing a plurality of analog video inputs;

b) a mixer for receiving said plurality of digitized video signals and spatially mixing said signals in real time into a single frame of a predetermined n by m pixel image;

c) a video compressor for compressing each said single frame images;

d) a transmitter for transmitting said images; and

e) a receiver for receiving and decompressing said transmitted images.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the invention will be obtained by reference to the detailed description below in conjunction with the following drawings in which:

Figure 1 is a block diagram of a video transmitter subsystem according to an embodiment of the invention;

Figure 2 is a schematic diagram of a singe frame;

Figure 3 is a software flow diagram for the video transmitter system;

Figure 4 is a schematic diagram of digital video system according to the present invention; and

Figures 5(a) - (t) illustrate various screen shots of a user interface.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to Figure 1 a video transmitter subsystem according to an embodiment of the invention is shown generally by numeral 1. The video subsystem1 is a standalone unit, which is capable of spatially mixing four analog NTSC or PAL video inputs in real-time into a single frame of 640 x 480 pixels image. Each input image occupies a quadrant of the frame 60 as shown schematically in figure 2. The video subsystem1 compresses each image frame 60 using wavelet compression based hardware for a programmable compression ration of 4:1 to 350:1. An advantage of wavelet compression is the blocky artifacts, commonly appearing

in JPEG type compression, are totally eliminated. The resulting wavelet compressed image data is then transmitted via a (100MB or better) Ethernet network in which plurality of video transmitters may be joined together.

In general, the video mixer is considered to have two main sections. First, is a computer (running QNX operating system) and second, is a PCI PC plug-in board which processes the incoming video images and performs wavelet compression. A number of video mixers may be installed in a LAN hosted for example by an NT ™ server. The server is responsible for retrieving and storing images obtained from the mixers. In this way software, updates to the video mixers may be performed from the central server or from the first mixer, thereby minimizing on-site maintenance of each mixer. The computer may be a PC motherboard of a baby AT type. The computer should include sufficient memory, hard disk space and power source to run the operating system and video transmitter application program (discussed below). This type of computer including a PCI interface and network adapter is well known in the art and will not be discussed further.

The video mixer 1 comprises an analog front end 4 having four independent video inputs A, B, C and D coupled to respective anti-alias passive circuits for lightly low-pass filtering the video inputs which are then fed into respective text overlay chips (not shown) before being coupled to respective video decoders 8 labeled DecoderA, DecoderB, DecoderC and DecoderD respectively. In a preferred embodiment, the decoders are a Samsung KS0122 multistandard video decoder and the text overlay chip is a uPD6465. Details of these devices including application notes are available in their respective data sheets incorporated herein by reference. Based on the above decoder device, the composite video signals are digitized into 4:2:2 8-bit YcrCb data format at a digitization frequency of 12.27 MHz by the decoders 8. The digitization is selected for a square pixel type and therefore the spatial resolution is 640x480 pixels per field.

The digitized outputs are coupled to a time base corrected spatial mixer 20, which comprises a plurality of FIFO registers 24 for storage of pixel data from the analog front end; a time base corrector 26 and a quadruple retrieval controller (QRC) 28. The spatial mixer 20 assembles a 640x480 pixel frame which is comprised of four horizontally decimated image fields (of size 320x240) from each of the digitized outputs.

Each of the four digitized channels is coupled to a dedicated bank of the FIFO's such that each bank stores at least 320x240 pixels. The FIFO banks in each of the channels are

coupled to a common output video bus and are individually addressable such that any of the 320x240 fields from any of the channels may be retrieved. In a preferred embodiment, each FIFO register bank consists of two uPD42280 FIFO chips. Each chip is capable of holding one 320x240 field of pixel data. Details of these devices including application notes are available in their data sheets incorporated herein by reference.

The pixel data retrieval is asynchronous to any of the input video timing, thus the time base corrector 26 is coupled to the FIFO's and the decoders to control the retrieval process when the input video timing and the retrieved data timing drift with respect to each other.

The retrieved data from the FIFO's are coupled to a wavelet compression engine 40, which is implemented in an Analog Devices multiformat video Codec chip, part number ADV601. The ADV601 accepts YcrCb pixel data from its video interface and performs wavelet compression thereon. The compressed data is output to a host bus interface 44. Conversely the chip may also perform decompression of data received on its host bus interface. The ADV601's host interface is a 32-bit wide interface and consists of four 32-bit registers. These registers are I/O mapped onto a PCI host bus. Compressed data can thus be transferred using PCI burst I/O when an interrupt is generated by data being available in the ADV601 internal FIFO.

Since the wavelet compression engine can take video on a field by field (i.e. 640x240) basis, the quadruple image frame must be fed into the engine in two halves – upper and lower half. The retrieval algorithm for implementing this is implemented in the QRC. It may be noted that the spatial mixer may also be bypassed in order to provide full 640x480 fields to the wavelet engine for compression. As described above, the quadruple image mixer is made up of four banks of field FIFOs (uPD42280). Each decoder channel has a dedicated FIFO bank which is capable of storing two quarter size fields of video. The incoming digitized video is written into the FIFO bank using decoder timing. Since the stored video is of quarter size, the video data from the decoder is decimated first (by the decoder). Each bank of stored video is read in sequence to construct a quadruple image frame of sixw 640x480. The tope two images are retrieved as field-1 input to the wavelet engine while the bottom two images are retrieved as field-2. The reason that two banks of FIFO are needed for each decoder channel is that TBC function is implemented to avoid read and write collision caused by asynchronous timing between the input and ADV601 video timing. The TBC function is implemented in the firmware.

For single source compression, this quadruple mixer is bypassed. The video data and video sync signals are fed directly into the wavelet engine which is placed in slave mode. Write control signals are generated by an Altera chip, preferably 6016which is capable of taking four asynchronous clocks from each decoder.

Retrieval logic signals, ADV601 syncs and read control signals are generated by another Altera chip.

In quadruple mode,ADV601 is placed in master mode where all the video sync signals are generated. In single source mode, the sync signals are provided by the video decoders.

During compression the ADV601 requires external numeric processing on the statistics of the current field data. This means that an embedded computer will evaluate the bin-width values based on the statistics of the field data. The bin-width statistics are transferred via the ADV601 host interface and then the PCI interface to or from the embedded computer.

The PCI interface consists of a device, which is capable of bridging the on-board devices onto the PCI bus. It manages the I/O and memory mapping, read/write cycles and DMA cycles. It should be capable of bursting data at a rate of 20-30 MB per second. Typically the PCI interface is implemented by a PLX PCI9080 PCI accelerator chip.

A generals purpose 8-bit I/O port is provided to the PCI controller and is configured as an 4 input 4 output bits. It is mapped on the PCI bus i/o, and is thus under the control of the embedded computer. This port may be used to control alarm equipment.

In a preferred embodiment, a video encoder 50 is provided for generating composite and S-video output signals for monitoring or for playback of the decompressed video frame. The encoder is a Brooktree BT866 device that is configured in a slave mode and is coupled to the timing from the ADV601 chip. Data for the encoder is tapped off the data stream to the aADV601 video bus. This data is non-interlaced, therefore a field FIFO register 52 is needed to convert the data back to interlaced video before it is fed to the encoder. The FIFO registers 52 are implemented in four uPD42280 devices used to hold two fields of pixel data.

Referring now to figure 3, a software flow diagram for the video mixer 1 is shown generally by numeral 100. The software in general is centered on the transmission of compressed image data to the system host via the Ethernet LAN. The software comprises an application program 116 for executing high level commands from a remote host. This

includes video channel switching, alarm ports reporting, transmission of wavelet data to the remote host when requested, Bin-width calculation, track burn-in time/date, general maintenance of the connection to the network and self diagnostics when requested by the host. The software also includes a number of low-level drivers and libraries.

A device driver module 102 is provided for the PCI 9080 chip for communication between the video mixer and the computer. The driver 102 includes low-level services for handling PCI bus i/o, DMA and IRQ. It contains functions for translation between physical and linear memory, interrupt dispatcher and bus master control. Detailed implementation of these functions is well known in the art and will be not discussed further. The software also includes a I2C bus communication module 104 for obtaining data packets from the application and translating data into signal streams. A video control module 106 is provided for controlling the video hardware including decoder, encoder and field FIFO. The functions implemented by this module include selection of video capture mode, control of contrast and brightness and initialization of video chips, NTSC/PAL selection and such like. A TCP/IP manager108 is implemented as a socket for handling command and compressed data transmission to the host. It calls a QNX LAN driver110 to perform the data transmission. A wavelet control module 112 implements functions to control the data transfer between the ADV601 and the host memory, compression ratio, ADV601 initialization and such like. A Time/Date port control module 114 is provided to load a desired burn-in time/date on each selected video channel.

Referring to figure 4, a schematic diagram of a digital video system is shown generally by numeral 400. The system comprises a plurality of video mixers 1 including their respective computer coupled to a host computer 404 via an Ethernet LAN 406. The host computer 404 includes a software-based receiver, which communicates with the multiple digital video transmitters 1 on the Ethernet network to receive compressed digital images. The received images are decompressed in software and displayed 410 in near real time (12-15 frames per second) and can be recorded to a hard disk 412 in real time (30 fps) in their native compressed form. In a preferred embodiment, a database is used for image storage, retrieval, playback and manipulation. If multiple receiver stations are coupled to the network then any station may have access to any of the other receivers live or recorded data.

The receiver includes modules for setting alarm points and outputs at each video receiver. In a preferred embodiment, the receiver software is implemented in Visual Basic

and the underlying database is a Btrieve database engine with option to use other proprietary types of database engines. The receiver also includes image processing software for displaying multiple views of multiple cameras and a user input interface shown in figures 5 for setting various parameters such as security, camera scheduling, reports and such like.

Thus, it may be seen that the present invention provides a fully integrated near real time video surveillance, monitoring and capture system that is cost effective and highly flexible. Further, the mixer does not lose any frames during the actual mixing, i.e. at 30 fps. Other configurations of the mixer may also be implemented, such as having one or more mixer boards plug directly into the receiver computer without using a LAN.

Although the invention has been described with reference to certain specific embodiments, various modifications thereof will be apparent to those skilled in the art without departing from the spirit and scope of the invention as outlined in the claims appended hereto.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A digital video system comprising:

a) a video mixer for spatially mixing a plurality of analog video input signals in real time and compressing said mixed signals for transmission; and

b) a receiver for receiving and decompressing said compressed signals for display in near real time.

2. A digital video system as defined in claim 1, said video transmitter including

a) a video digitizer for receiving and digitizing a plurality of analog video inputs;

b) a spatial mixer for receiving said plurality of digitized video signals and spatially mixing said signals in real time into a single frames of a predetermined n by m pixel images; and

c) a video compressor for compressing each said single frame image.

3. A digital video system as defined in claim 1, said compression being wavelet compression.

4. A digital video system as defined in claim 1, said video mixer including a network interface for transmitting said compressed signals on a LAN.

5. A digital video system as defined in claim 1, including a plurality of video mixers coupled to a network and said receiver for receiving said compressed imaged from said plurality of transmitters.

6. A digital video system comprising:

a) a video digitizer for receiving and digitizing a plurality of analog video inputs;

b) a mixer for receiving said plurality of digitized video signals and spatially mixing said signals in real time into a single frames of a predetermined n by m pixel images;

c) a video compressor for compressing each said single frame images;

d) a transmitter for transmitting said images; and

e) a receiver for receiving and decompressing said transmitted images.

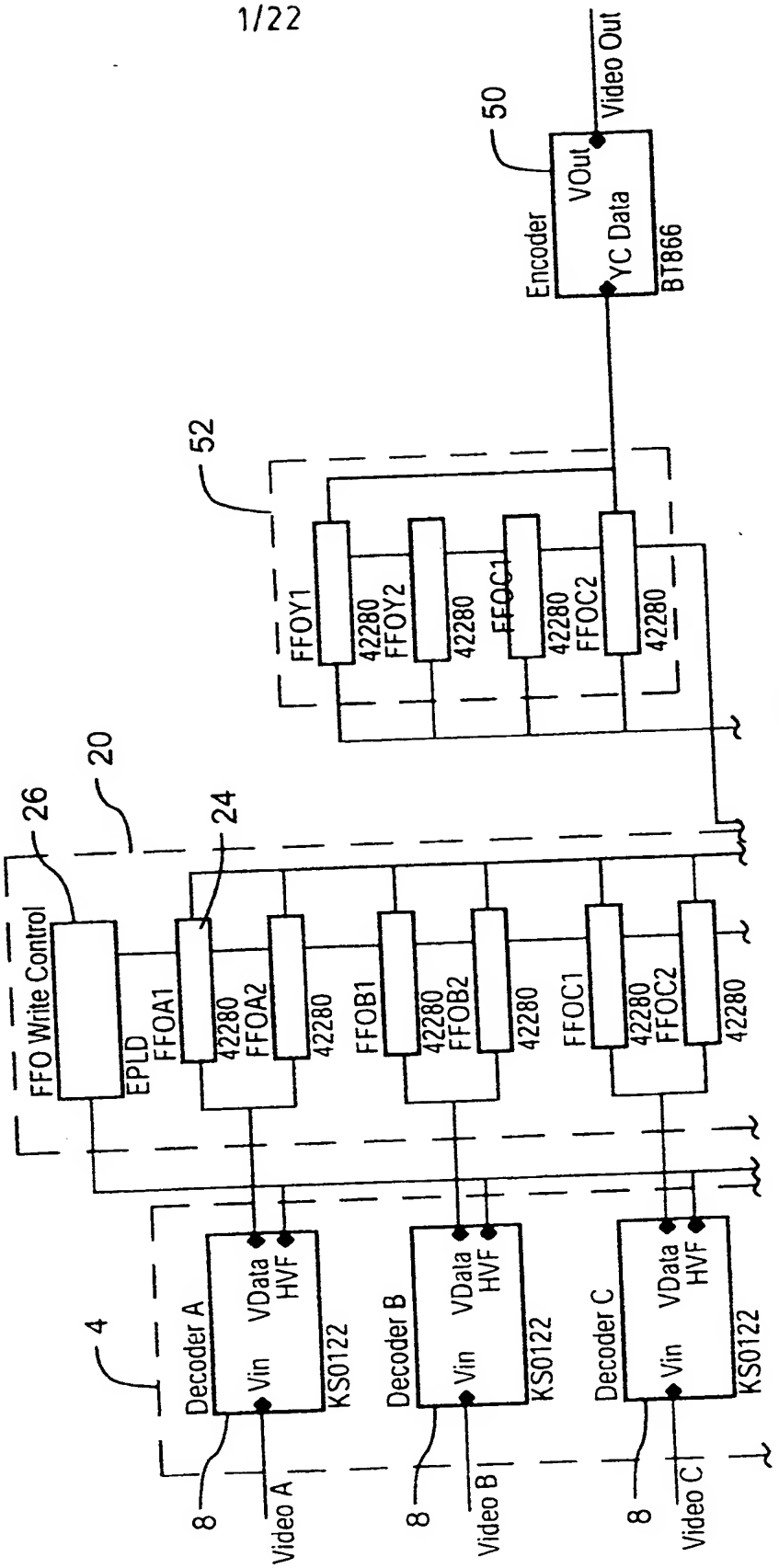
7. A method for combining a plurality of video signals in a video mixer, comprising the steps of :

a) digitizing each of a plurality of analog video input channels as a sequence of frames;

b) storing said digitized frames for each channel;

c) retrieving said stored frames in accordance with a predetermined spatial layout of said channels; and

d) compressing each said retrieved frame to produce a single frame of said spatially arranged frames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VOut
Encoder
YC Data
BT866
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FFOY1
42280
FFOY2
42280
FFOC1
42280
FFOC2
42280
20
26
24
FFO Write Control
EPLD
FFOA1
42280
FFOA2
42280
FFOB1
42280
FFOB2
42280
FFOC1
42280
FFOC2
42280
4
Decoder A
VData
HVF
Vin
KS0122
Decoder B
VData
HVF
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HVF
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Video A
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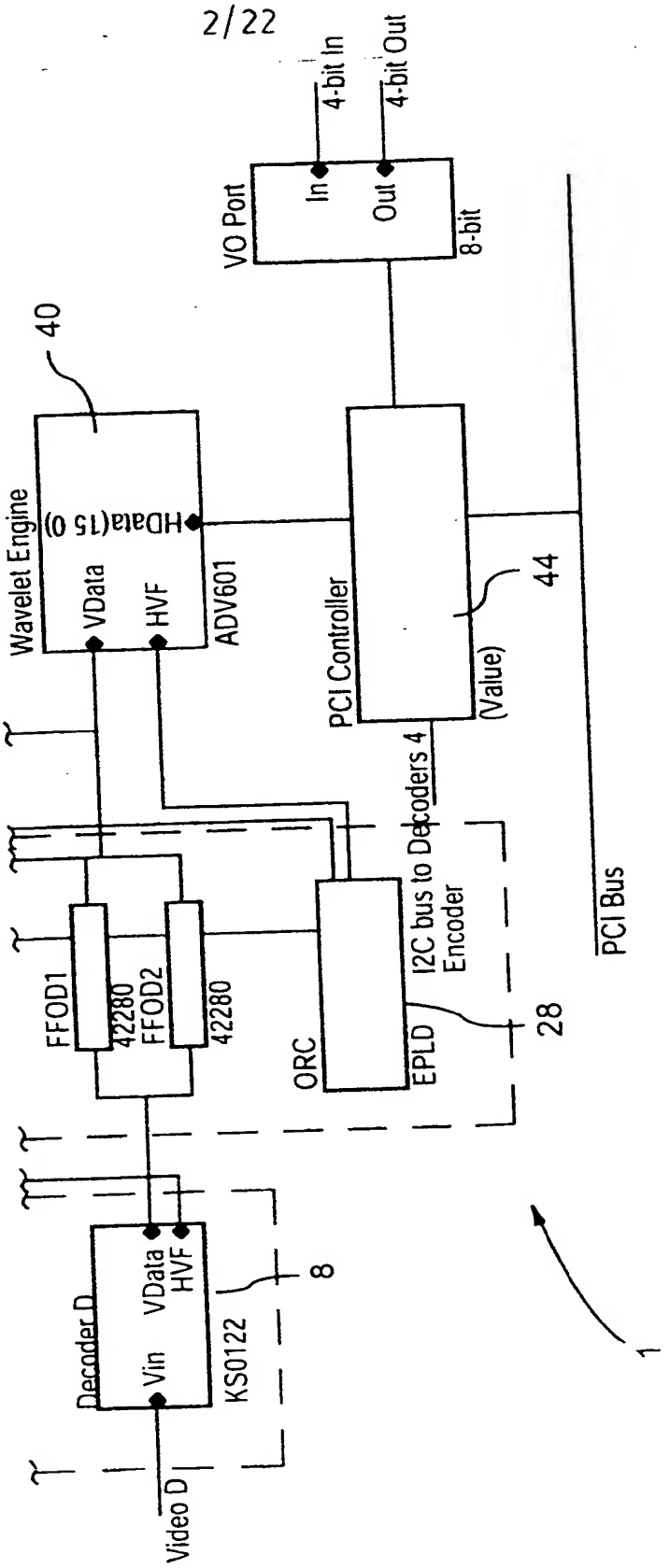
Video B
8
Video C

FIG.1A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4-bit Out
VO Port
In
Out
8-bit
40
Wavelet Engine
HData(15 0)
VData
HVF
ADV601
PCI Controller
44
(Value)
PCI Bus
I2C bus to Decoders 4
Encoder
FFOD1
42280
FFOD2
42280
ORC
EPLD
28
Decoder D
VData
HVF
Vin
KS0122
8
Video D
1

FIG.1B

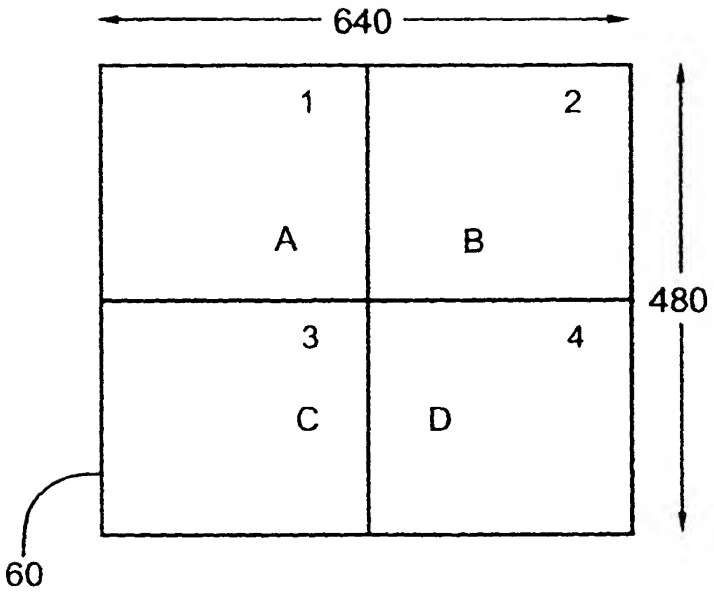


FIG.2

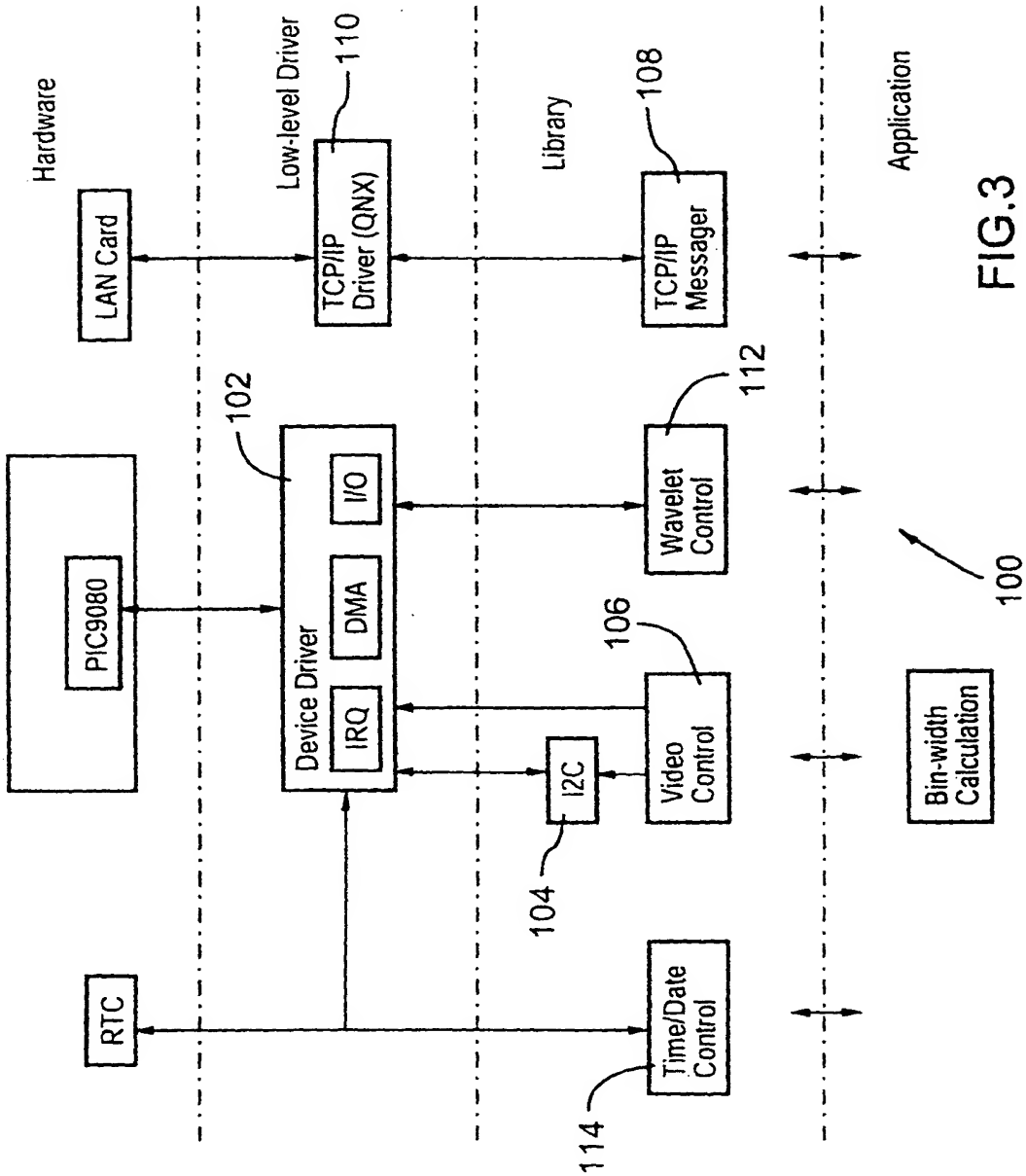

Hardware
Low-level Driver
Library
Application
LAN Card
TCP/IP Driver (QNX)
TCP/IP Messager
110
108
102
PIC9080
Device Driver
I/O
DMA
IRQ
Wavelet Control
112
106
Video Control
I2C
104
RTC
Time/Date Control
114
Bin-width Calculation
100

FIG.3

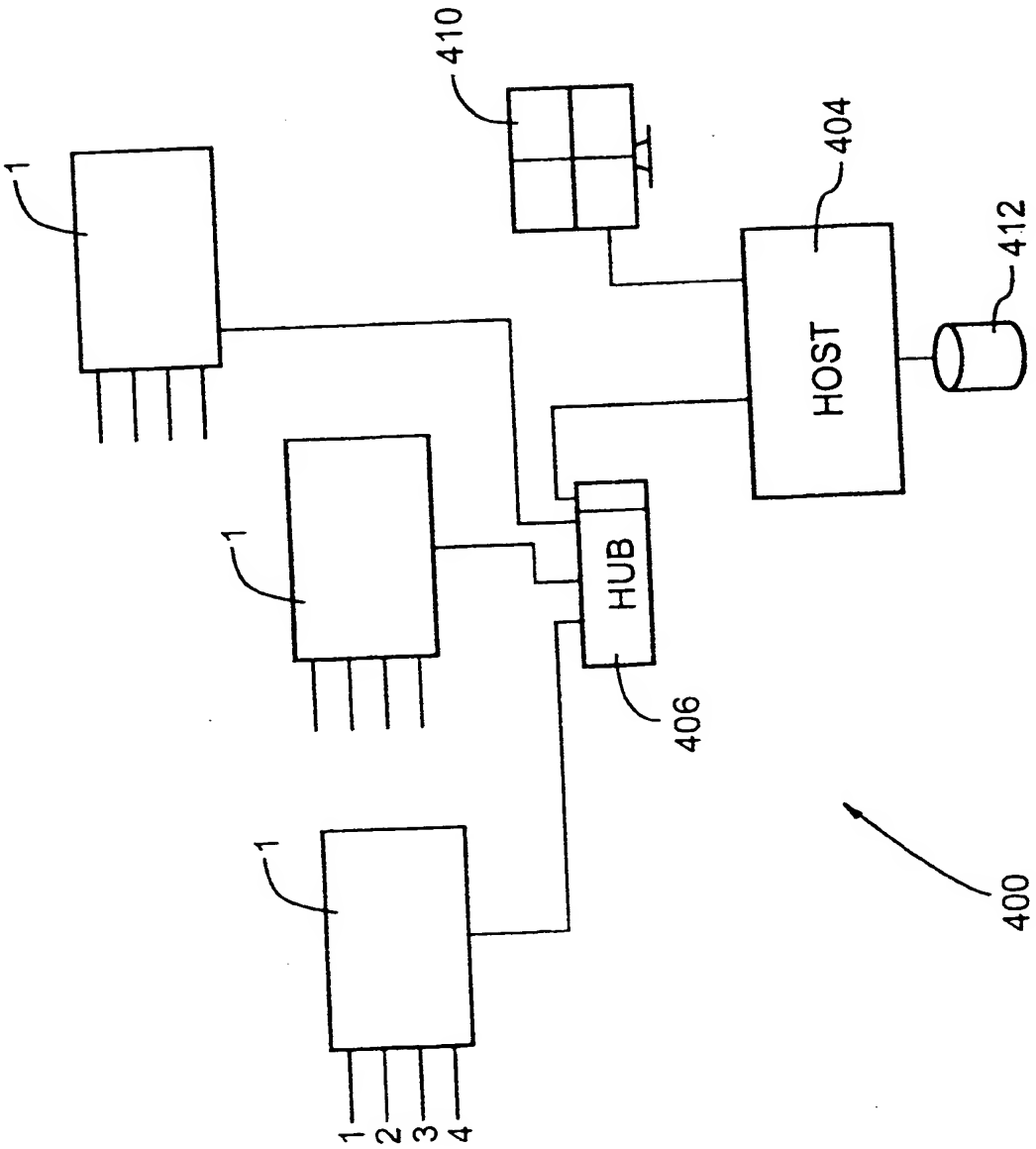


FIG.4

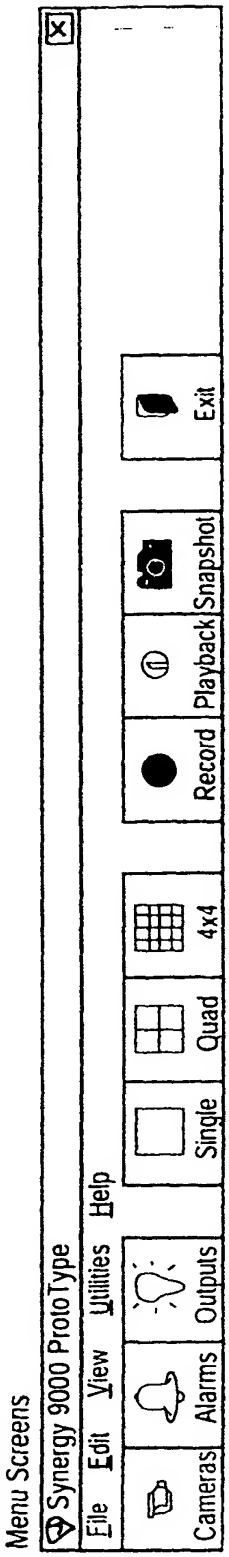
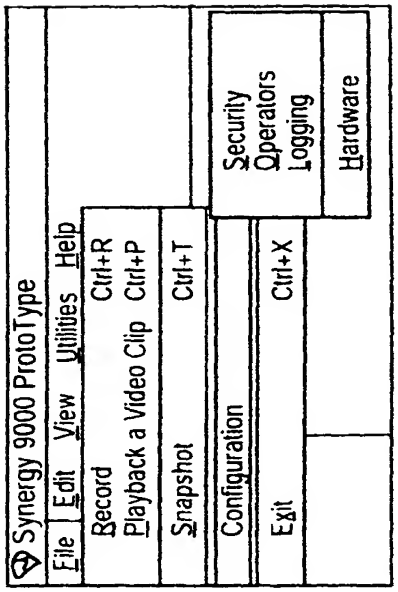

Menu Screens
Synergy 9000 ProtoType
File Edit View Utilities Help
Cameras
Alarms
Outputs
Single
Quad
4x4
Record
Playback
Snapshot
Exit
File
Record
Playback
Take a Snapshot
Setup
Security
Logging
Operators
Hardware
Exit

FIG.5A


Synergy 9000 ProtoType
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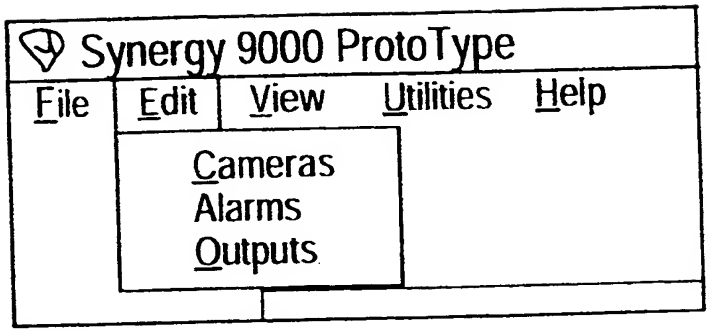
Playback a Video Clip Ctrl+P
Snapshot Ctrl+T
Configuration
Exit Ctrl+X
Security
Operators
Logging
Hardware
Edit
Cameras
Alarms

FIG.5B

Outputs



View

16 Cameras
4 Cameras
1 Camera
Cycle Cameras

FIG.5C

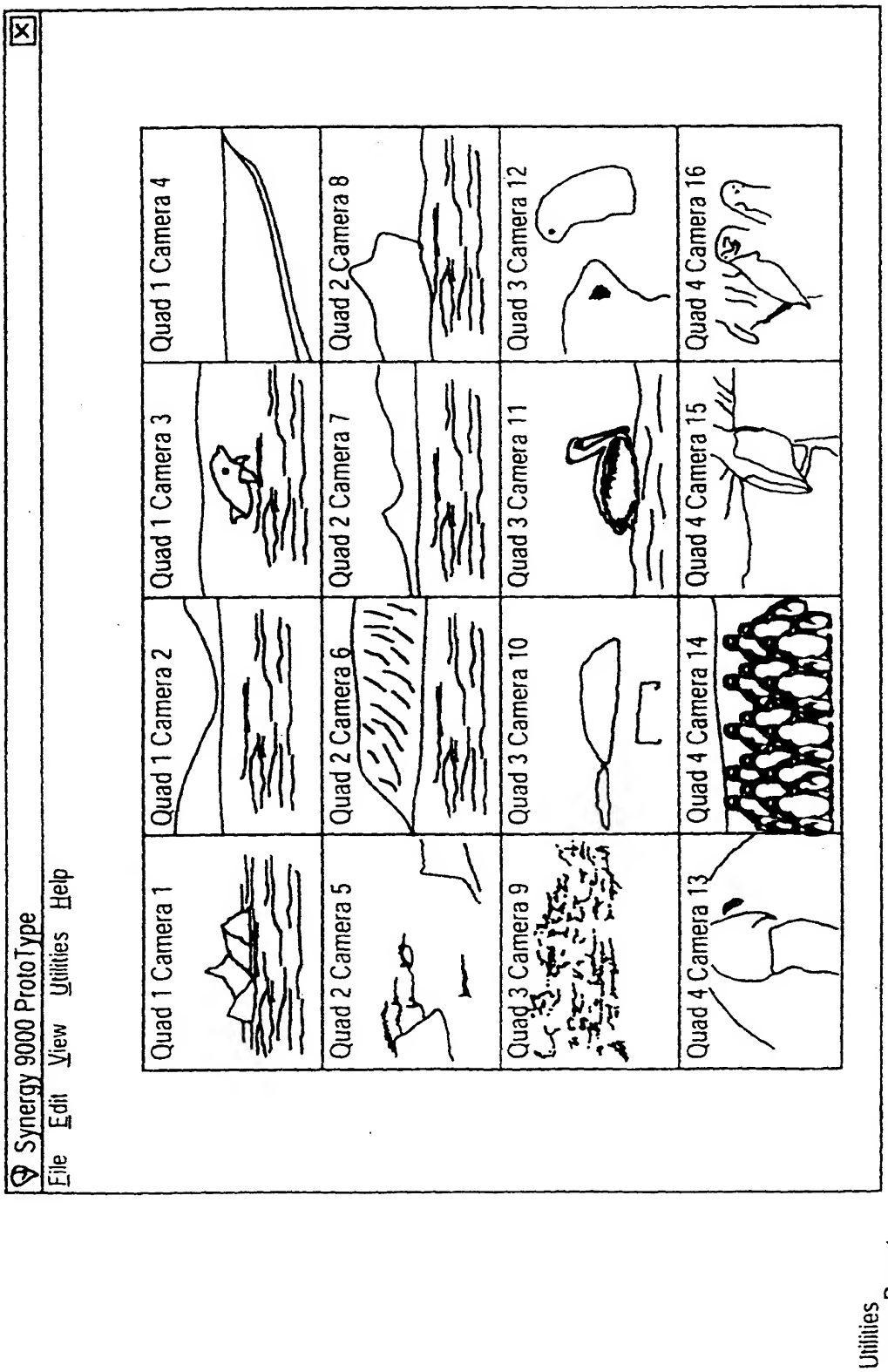
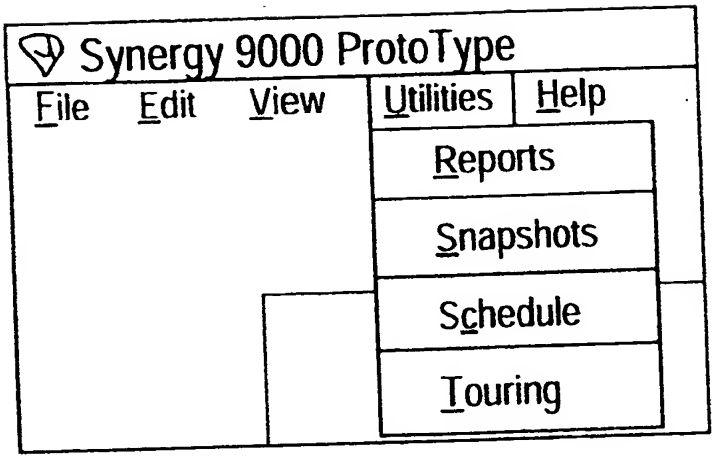

Synergy 9000 ProtoType
File Edit View Utilities Help
Quad 1 Camera 1
Quad 1 Camera 2
Quad 1 Camera 3
Quad 1 Camera 4
Quad 2 Camera 5
Quad 2 Camera 6
Quad 2 Camera 7
Quad 2 Camera 8
Quad 3 Camera 9
Quad 3 Camera 10
Quad 3 Camera 11
Quad 3 Camera 12
Quad 4 Camera 13
Quad 4 Camera 14
Quad 4 Camera 15
Quad 4 Camera 16
Utilities
Reports
Snapshots
Schedule

FIG.5D

Touring



Help

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Utilities Screens

FIG.5E

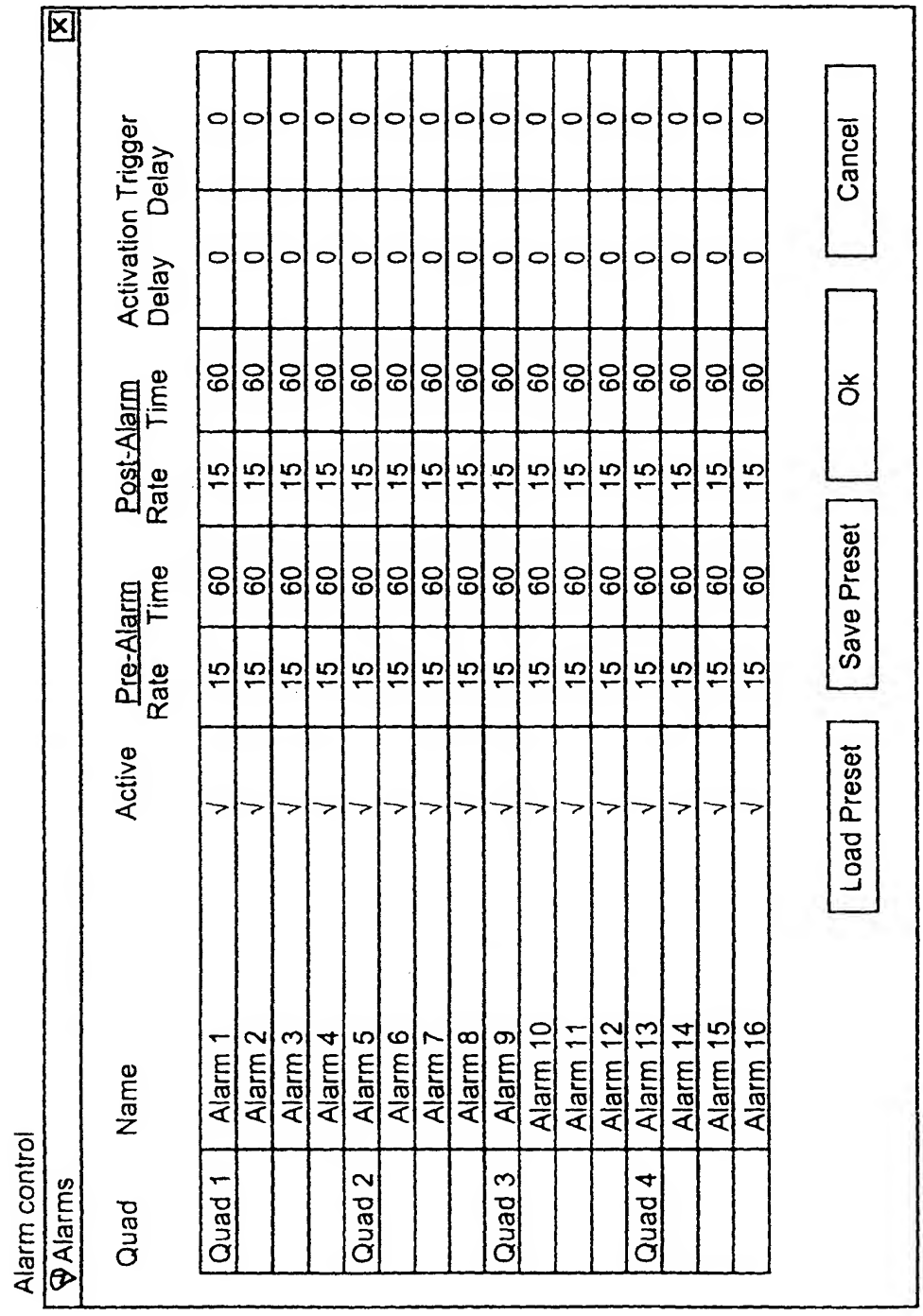
Alarm control
Alarms
Quad
Name
Active
Pre-Alarm Rate
Pre-Alarm Time
Post-Alarm Rate
Post-Alarm Time
Activation Trigger Delay
Activation Trigger Delay
Quad 1 Alarm 1 √ 15 60 15 60 0 0
Alarm 2 √ 15 60 15 60 0 0
Alarm 3 √ 15 60 15 60 0 0
Alarm 4 √ 15 60 15 60 0 0
Quad 2 Alarm 5 √ 15 60 15 60 0 0
Alarm 6 √ 15 60 15 60 0 0
Alarm 7 √ 15 60 15 60 0 0
Alarm 8 √ 15 60 15 60 0 0
Quad 3 Alarm 9 √ 15 60 15 60 0 0
Alarm 10 √ 15 60 15 60 0 0
Alarm 11 √ 15 60 15 60 0 0
Alarm 12 √ 15 60 15 60 0 0
Quad 4 Alarm 13 √ 15 60 15 60 0 0
Alarm 14 √ 15 60 15 60 0 0
Alarm 15 √ 15 60 15 60 0 0
Alarm 16 √ 15 60 15 60 0 0
Load Preset
Save Preset
Ok
Cancel

FIG.5F

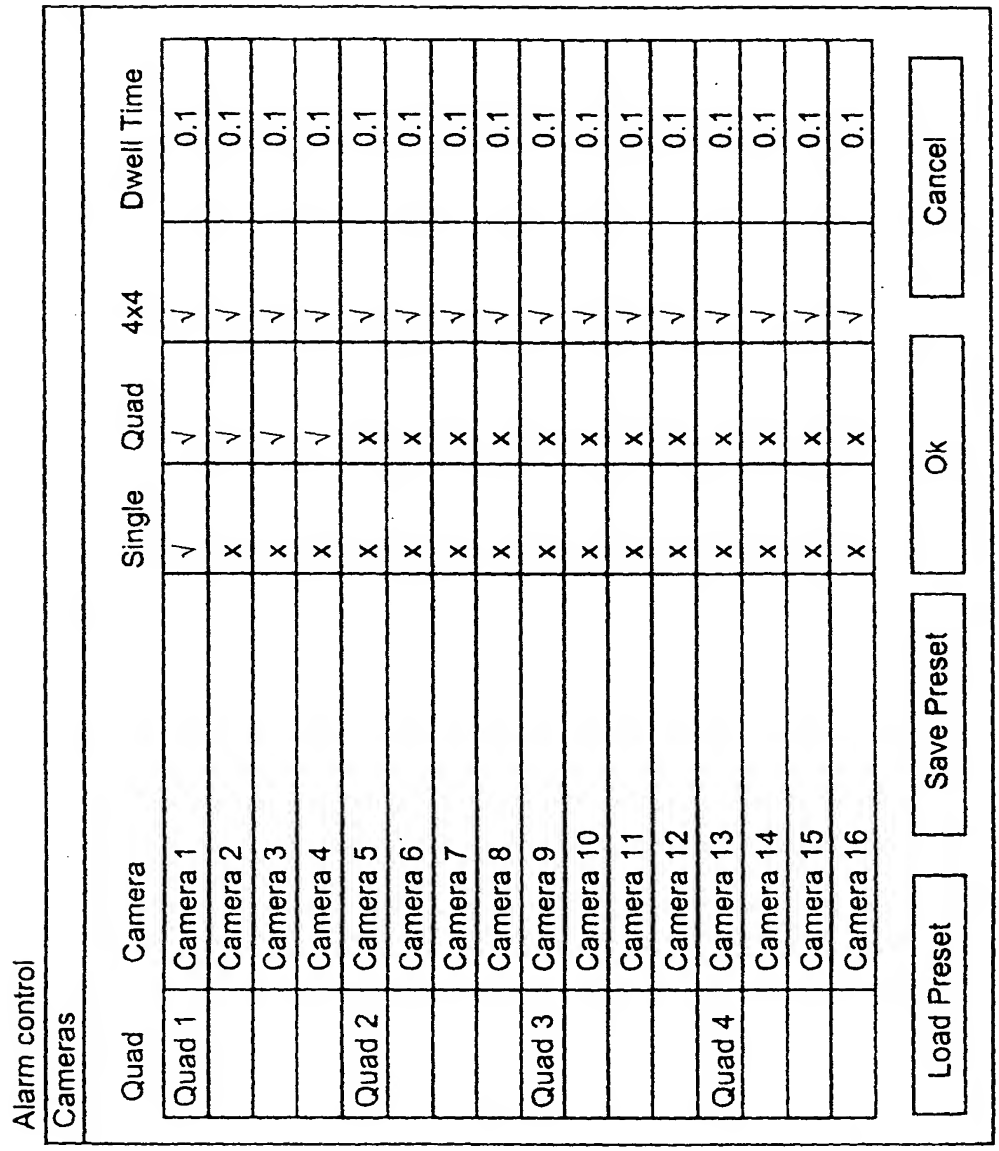
Alarm control
Cameras
Quad
Camera
Single
Quad
4x4
Dwell Time
Quad 1
Camera 1
√
√
√
0.1
Camera 2
x
√
√
0.1
Camera 3
x
√
√
0.1
Camera 4
x
√
√
0.1
Quad 2
Camera 5
x
x
√
0.1
Camera 6
x
x
√
0.1
Camera 7
x
x
√
0.1
Camera 8
x
x
√
0.1
Quad 3
Camera 9
x
x
√
0.1
Camera 10
x
x
√
0.1
Camera 11
x
x
√
0.1
Camera 12
x
x
√
0.1
Quad 4
Camera 13
x
x
√
0.1
Camera 14
x
x
√
0.1
Camera 15
x
x
√
0.1
Camera 16
x
x
√
0.1
Load Preset
Save Preset
Ok
Cancel

FIG.5G

Output Control

Outputs

Quad	Name	State
Quad 1	Output 1	√
	Output 2	√
	Output 3	√
	Output 4	√
Quad 2	Output 5	√
	Output 6	√
	Output 7	√
	Output 8	√
Quad 3	Output 9	√
	Output 10	√
	Output 11	√
	Output 12	√
Quad 4	Output 13	√
	Output 14	√
	Output 15	√
	Output 16	√

Ok Cancel

FIG.5H

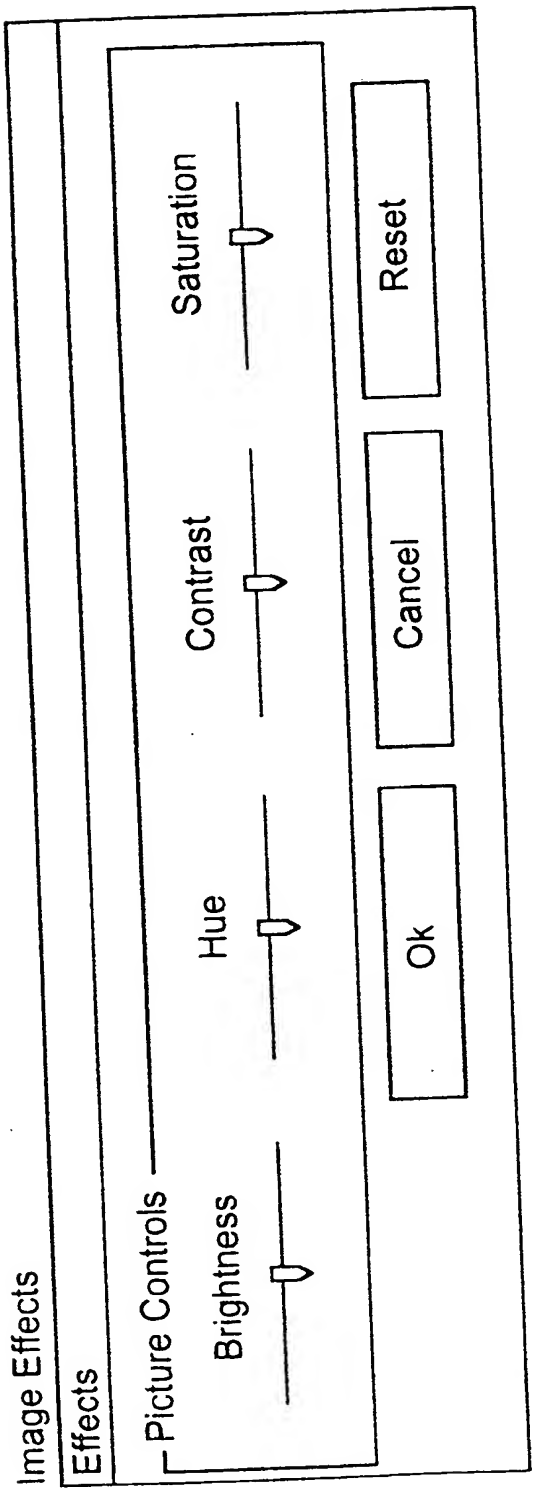
Image Effects
Effects
Picture Controls
Brightness
Hue
Contrast
Saturation
Ok
Cancel
Reset

FIG.5I

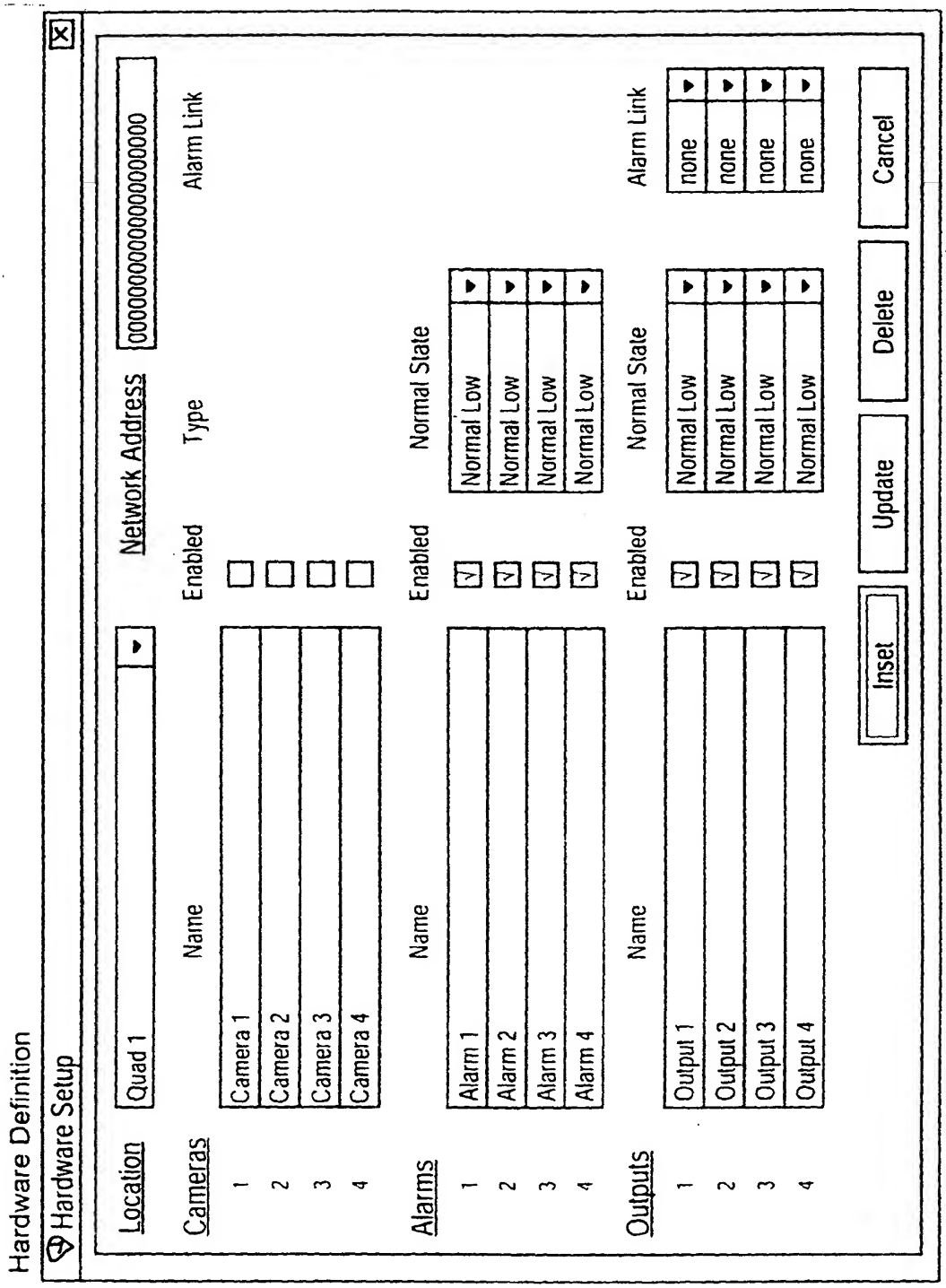
Hardware Definition
Hardware Setup
Location
Quad 1
Network Address
00000000000000000000
Cameras
Name
Enabled
Type
Alarm Link
1
Camera 1
2
Camera 2
3
Camera 3
4
Camera 4
Alarms
Name
Enabled
Normal State
1
Alarm 1
Normal Low
2
Alarm 2
Normal Low
3
Alarm 3
Normal Low
4
Alarm 4
Normal Low
Outputs
Name
Enabled
Normal State
Alarm Link
1
Output 1
Normal Low
none
2
Output 2
Normal Low
none
3
Output 3
Normal Low
none
4
Output 4
Normal Low
none
Inset
Update
Delete
Cancel

FIG.5J

Logging

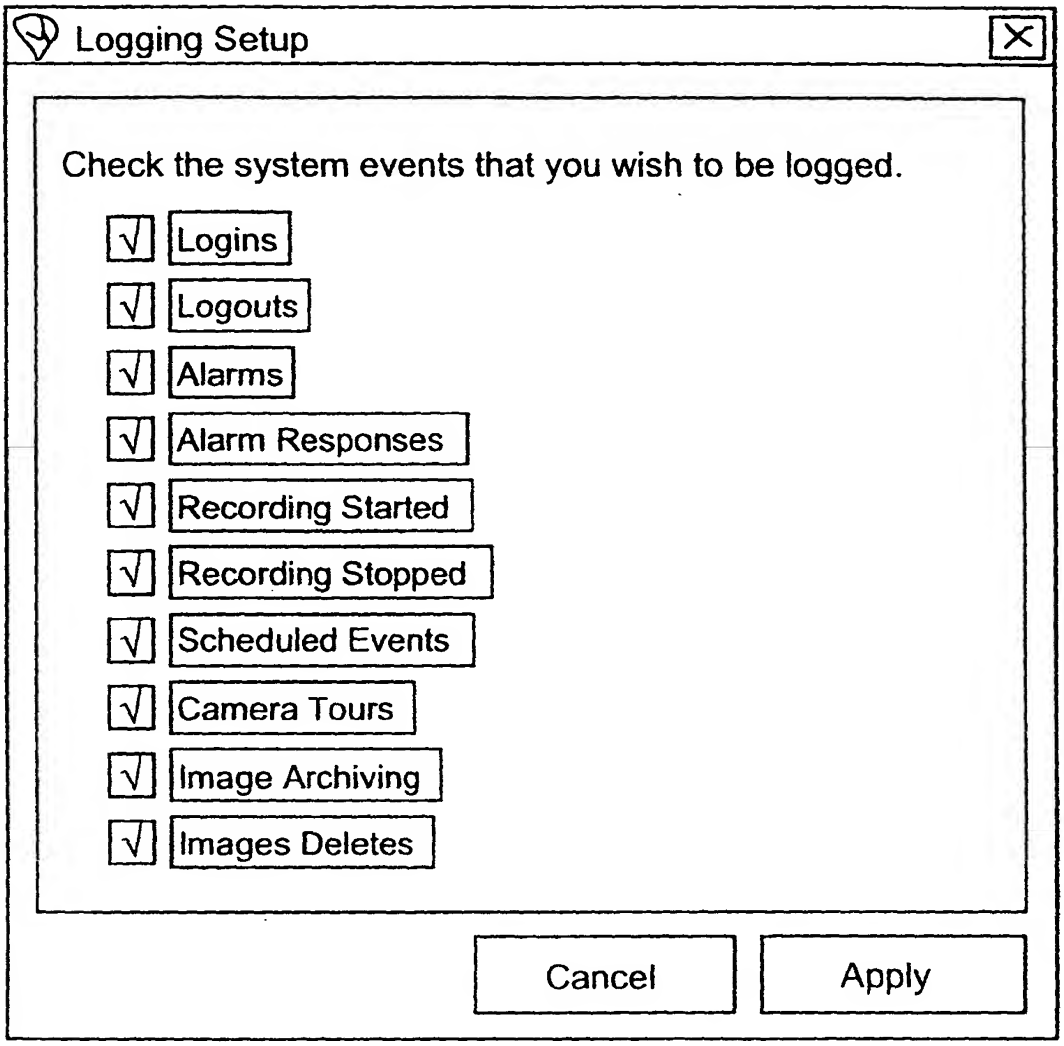

FIG.5K

Login

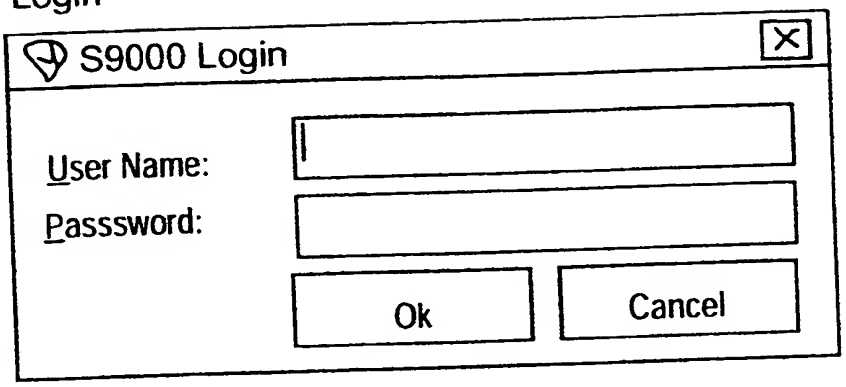

FIG.5L

Operator

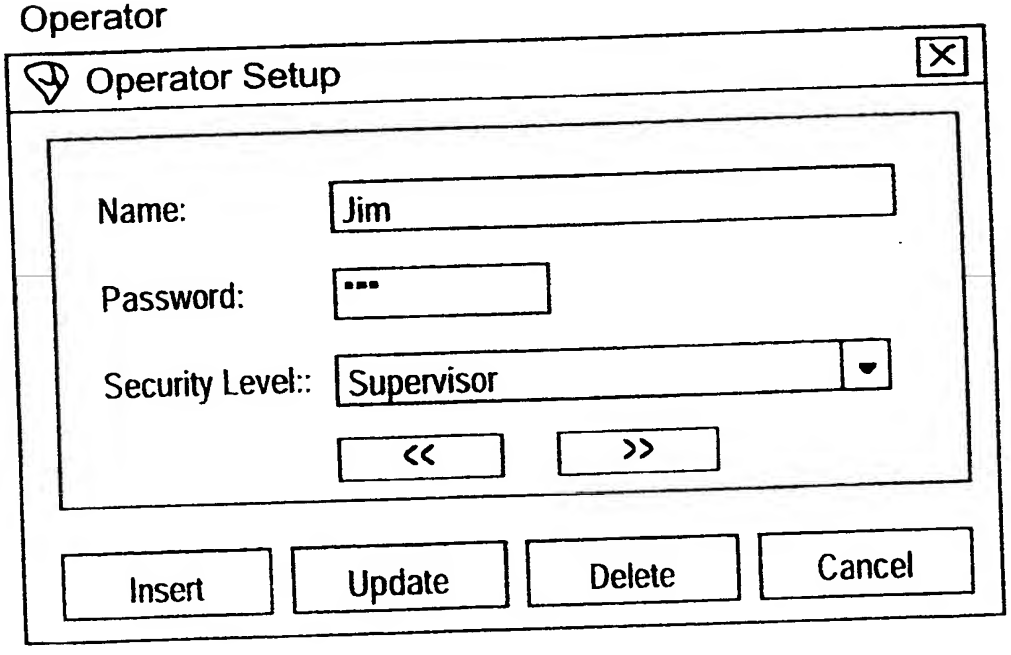

FIG.5M

Output Control

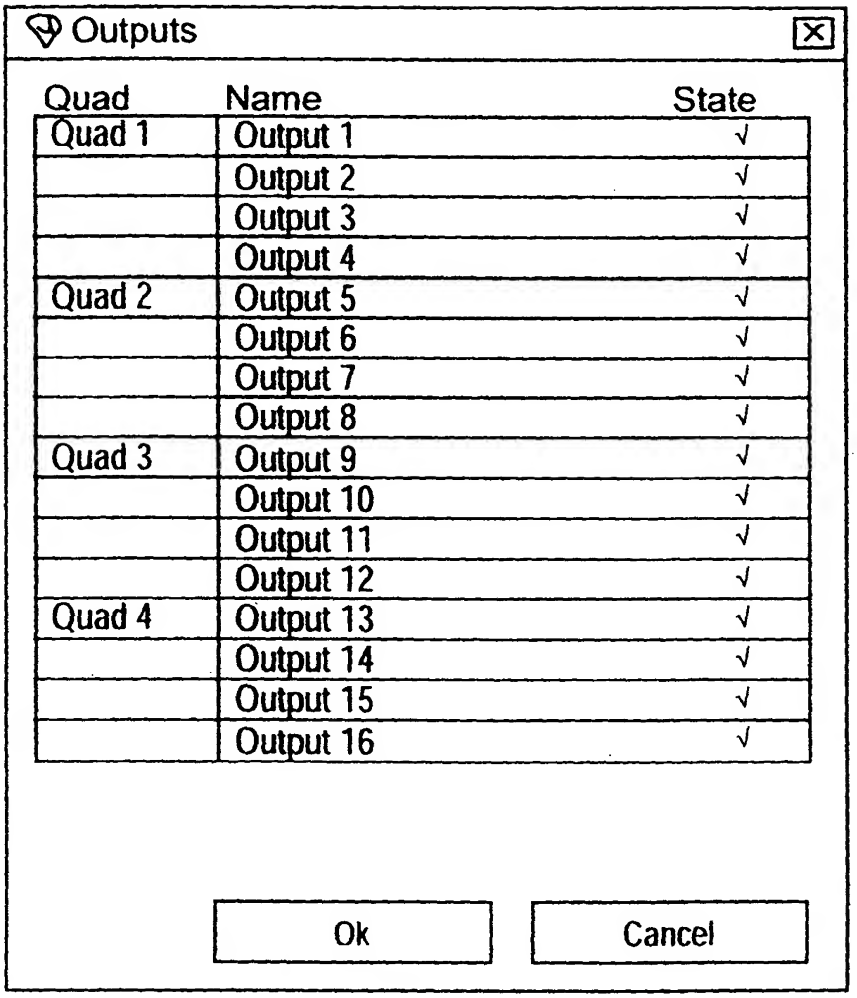

FIG.5N

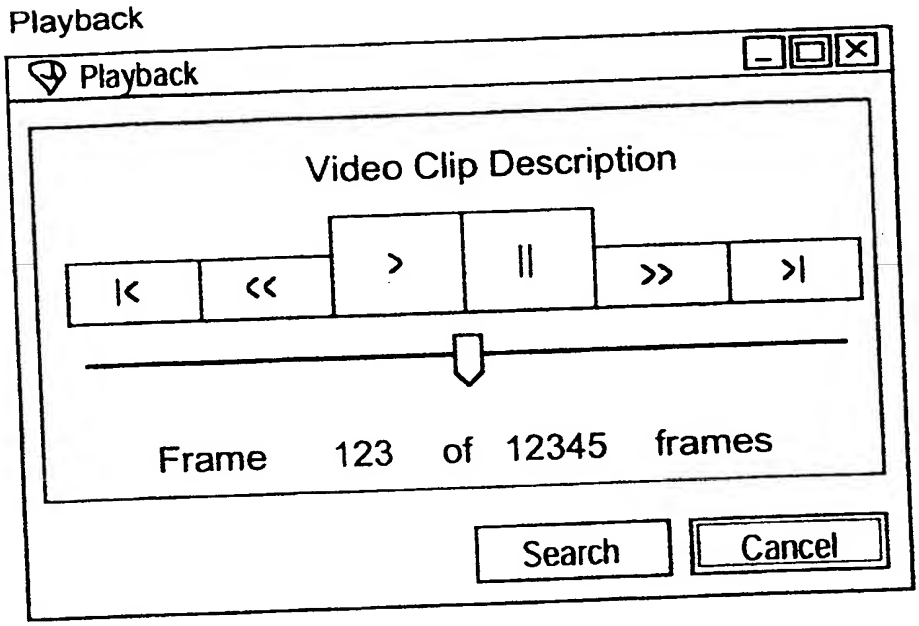
Playback
Playback
Video Clip Description
|<
<<
>
||
>>
>|
Frame 123 of 12345 frames
Search
Cancel

FIG.5O

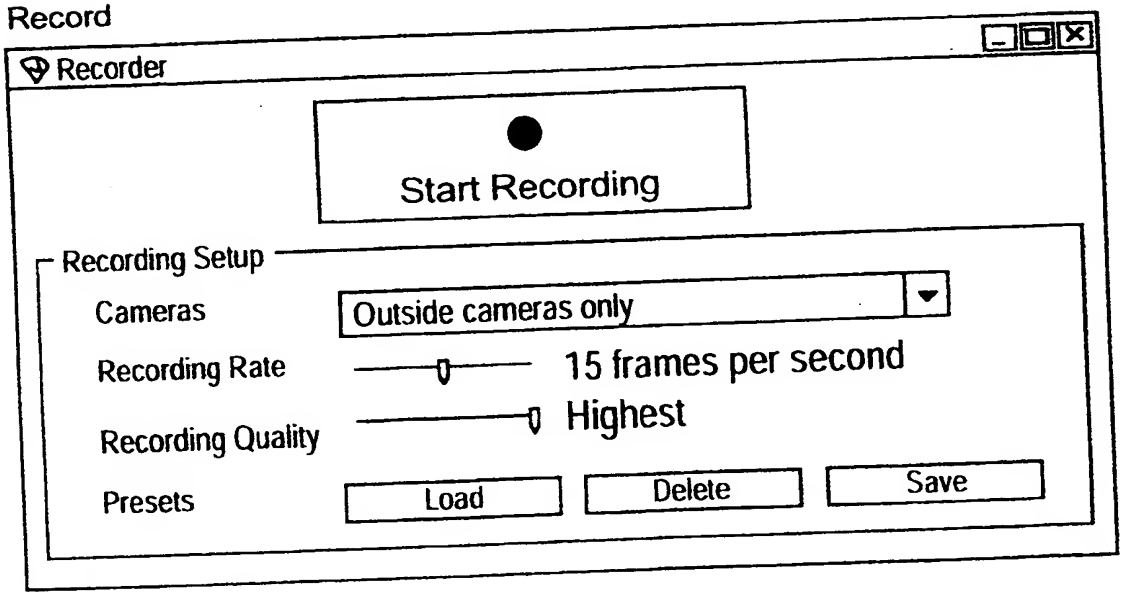
Record
Recorder
Start Recording
Recording Setup
Cameras
Outside cameras only
Recording Rate
15 frames per second
Recording Quality
Highest
Presets
Load
Delete
Save

FIG.5P

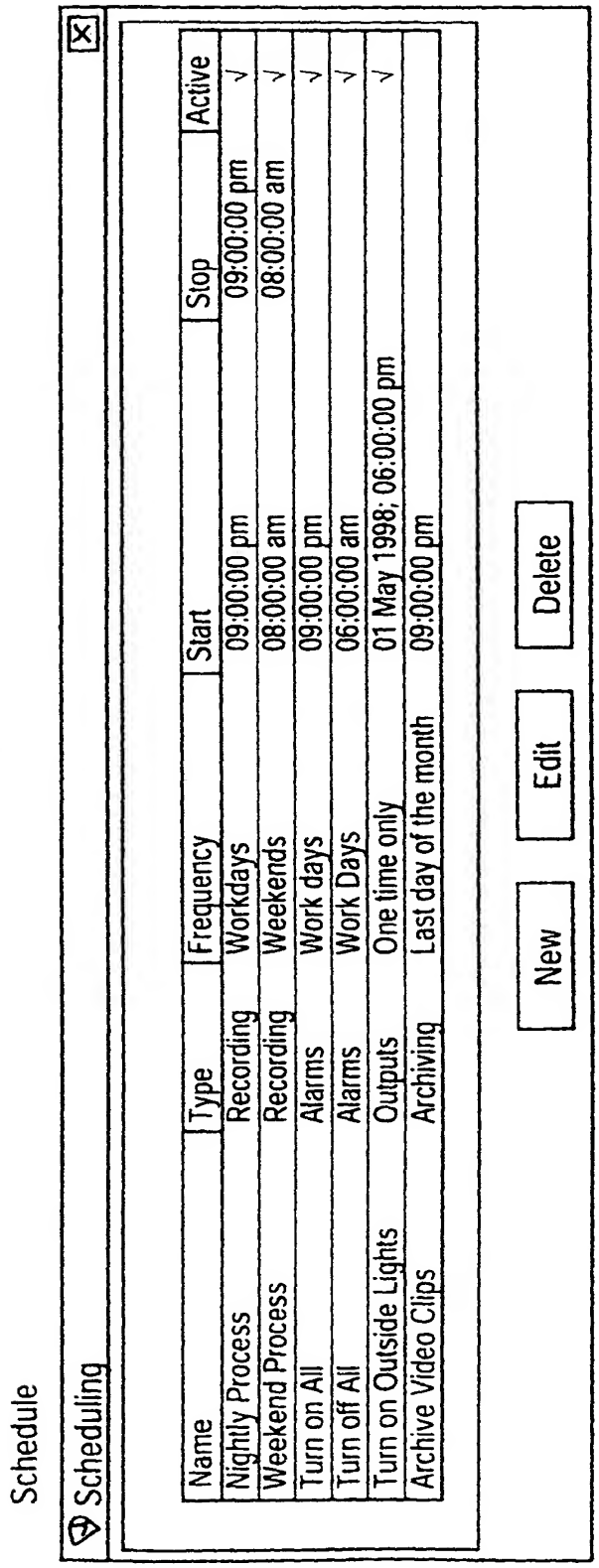
Schedule
Scheduling
Name
Type
Frequency
Start
Stop
Active
Nightly Process
Recording
Workdays
09:00:00 pm
09:00:00 pm
√
Weekend Process
Recording
Weekends
08:00:00 am
08:00:00 am
√
Turn on All
Alarms
Work days
09:00:00 pm
√
Turn off All
Alarms
Work Days
06:00:00 am
√
Turn on Outside Lights
Outputs
One time only
01 May 1998; 06:00:00 pm
√
Archive Video Clips
Archiving
Last day of the month
09:00:00 pm
New
Edit
Delete

FIG.5Q

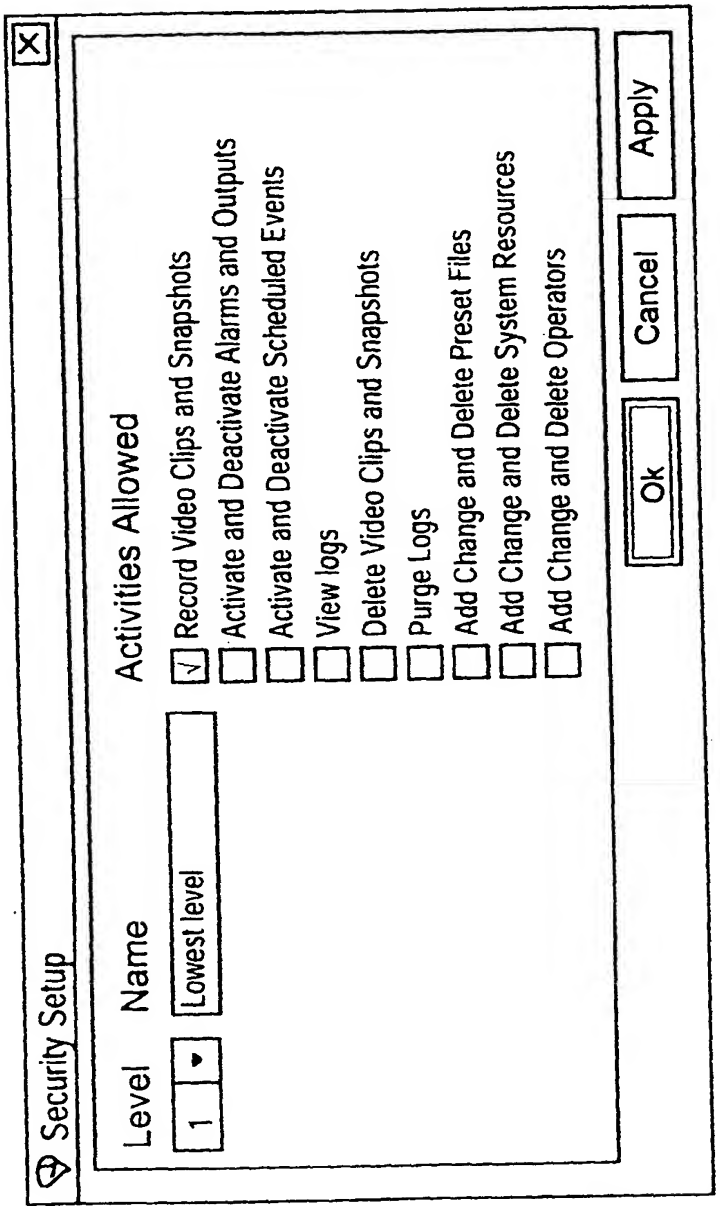
Security Setup
Level
1
Name
Lowest level
Activities Allowed
Record Video Clips and Snapshots
Activate and Deactivate Alarms and Outputs
Activate and Deactivate Scheduled Events
View logs
Delete Video Clips and Snapshots
Purge Logs
Add Change and Delete Preset Files
Add Change and Delete System Resources
Add Change and Delete Operators
Ok
Cancel
Apply

FIG.5R

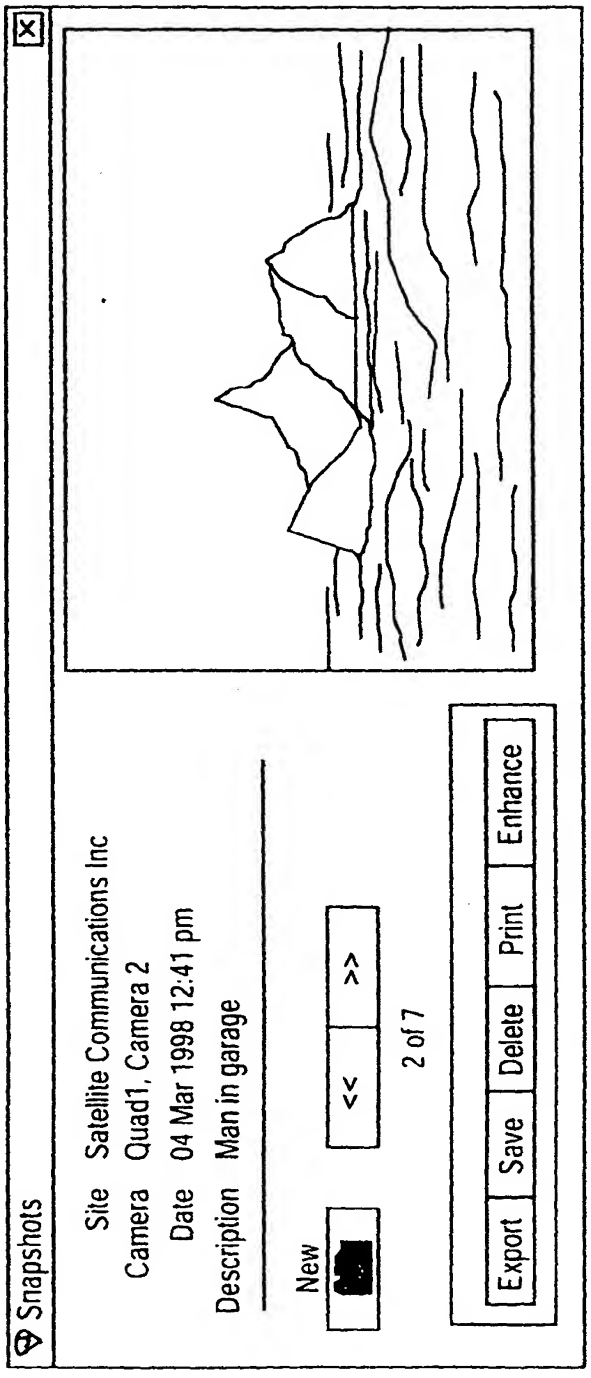
Snapshots
Site Satellite Communications Inc
Camera Quad1, Camera 2
Date 04 Mar 1998 12:41 pm
Description Man in garage
New
<<
>>
2 of 7
Export
Save
Delete
Print
Enhance

FIG.5S

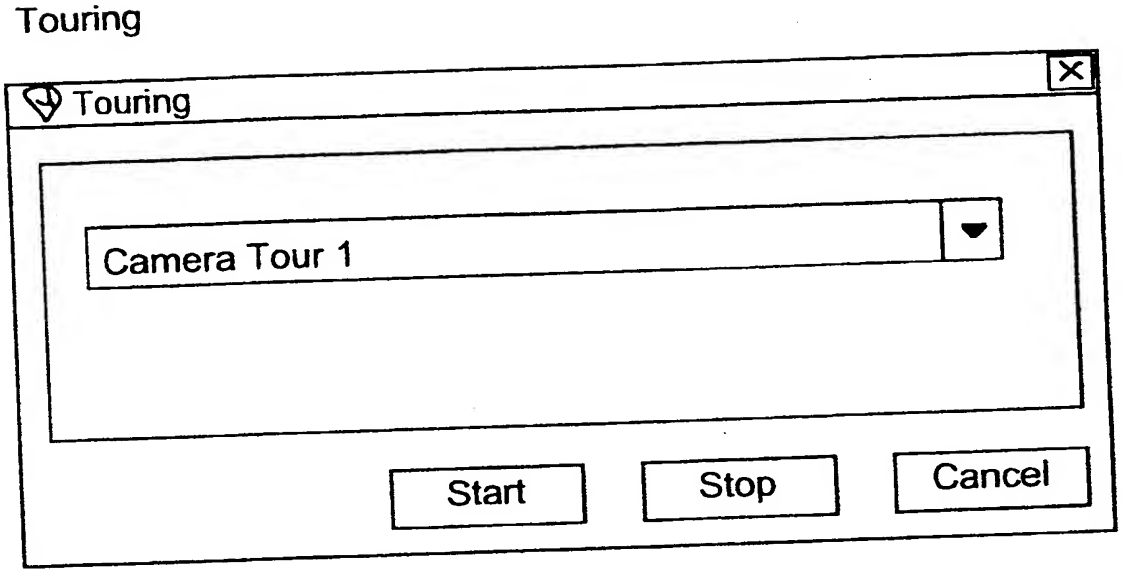

FIG.5T

INTERNATIONAL SEARCH REPORT

Inte. onal Application No
PCT/CA 00/00339

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N7/18 H04N7/15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 534 139 A (IBM) 31 March 1993 (1993-03-31)	1,6
A	abstract page 3, line 30 - line 48; figure 1	2,7
A	US 5 493 339 A (BIRCH CHRISTOPHER H ET AL) 20 February 1996 (1996-02-20) abstract column 5, line 49 -column 7, line 22; figures 6-10	1,3,5-7
A	US 5 754 242 A (OHKAMI TAKAHIDE) 19 May 1998 (1998-05-19) column 3, line 36 -column 4, line 12 column 6, line 19 - line 58; figure 1	1,6,7

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 July 2000	31/07/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Fuchs, P

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INTERNATIONAL SEARCH REPORT

Inte. .onal Application No
PCT/CA 00/00339

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 453 780 A (CHEN TING-CHUNG ET AL) 26 September 1995 (1995-09-26) column 1, line 5 - line 9 column 3, line 20 - line 60 column 4, line 58 -column 7, line 27; figures 6,7	1,6,7

1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. Jonal Application No
PCT/CA 00/00339

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